REMARKS/ARGUMENTS

Claims 1-4, 15-18, 22-25 and 30 are pending herein. Claims 15-18 and 22-25 have been amended to change "said sample solution" to --said capture solution-- in order to track the language of the independent claims. Claim 30 has been amended to clarify that the base plate comprises glass. This feature is supported by, for example, page 21, line 1 of the original specification.

Examiner Forman is thanked for courtesies extended to Applicants' representatives during a telephonic interview on October 23, 2003. During the interview, Examiner Forman stated that she would enter and consider (after final rejection) Declaration evidence proving that the claimed ink-jet process provides a structurally distinct biochip as compared to biochips produced using conventional pin-head arraying devices, such as those pin-head devices disclosed in the applied prior art of record. Accordingly, attached hereto is a Rule 132 Declaration of Mr. Toshikazu Hirota, wherein Mr. Hirota attests to the quantitative results of experimentation which proves that the claimed ink-jet process provides a structurally distinct biochip from biochips fabricated using conventional pin-head techniques. Entry and consideration of the Rule 132 Declaration are respectfully requested.

Examiner Forman also indicated that entry of the above-mentioned amendment to pending claim 30 after final rejection would be proper under Rule 116, because the change to pending claim 30 brings each of the specification and claim 30 into compliance with §132 and §112, first paragraph, respectively, and thus places the application in better condition for Appeal, if necessary.

For the reasons discussed above, Applicants have also amended claims 15-18 and 22-25. Entry of these amendments after final rejection is also proper under Rule 116, because the changes to claims 15-18 and 22-25 do not present new issues for Examiner Forman's

consideration and only serve to place the application in better condition for Appeal, if necessary.

1. The objection to the specification under §132 and the rejection of claim 30 under §112, first paragraph are noted, but deemed moot in view of rewritten claim 30 submitted above.

2. Claims 3, 4, 17, 18, 24, 25 and 30 were rejected under §102(e) over Audeh et al., or Mirzabekov et al., or Chenchik et al. in paragraphs 8, 10 and 12, respectively, of the Office Action. These rejections are respectfully traversed.

Pending independent claims 1, 3 and 30 each recite, among other things, that a plurality of spots of capture solutions are supplied onto a base plate by means of an ink-jet system. While claim 1 recites that the capture solution spots have different spot sizes, claims 3 and 30 each recite that the concentration of the capture material in the capture solutions varies from spot to spot. Each of pending independent claims 1, 3 and 30 further recite that all of the capture solution spots have uniform detection sensitivity.

The ink-jet process of supplying capture solutions onto the base plate is quantitatively proven (by the inventor's experimentation discussed below) to produce biochips that include capture solution spots having uniform detection sensitivity. Examiner Forman is well aware of the advantages of such uniform detection sensitivity. This result is possible because the ink-jet delivered capture solution spot sizes and capture material concentration per sample spot are accurately and precisely controlled in every instance. Such accurate, precise and reproducible capture solution spot sizes and capture material concentration per sample spot, which, again, are quantitatively proven to be attributable to the ink-jet process, are not attainable using conventional pin-head array techniques (discussed below).

The PTO admits that Audeh and Chenchik do not disclose the use of an ink-jet system to supply probe samples onto substrates (see Office Action page 5, paragraph 8 and page 10,

paragraph 12). Indeed, while Audeh discloses that a probe sample solution is spotted onto a substrate using a four-pin-head arraying device (see Audeh page 4, paragraph [0043]), Chenchik teaches that probe sample solutions are pin-spotted onto the substrate surface using a Biomek 2000 (Beckmann) Robot pin-head type arraying device (see, for example, column 18, lines 57-60).

The PTO is arguing that the Peltier thermostated pin disclosed in Mirzabekov is an ink-jet device. During the October 23, 2003 telephonic interview, Applicants' representatives cited to portions of the Mirzabekov patent that explicitly show that a Peltier thermostated pin is a pin-spotting device, a portion of which physically contacts the base plate surface and includes a Peltier element to control the temperature of the pin (see Mirzabekov patent column 11, lines 45-48; column 12, lines 8-20, especially lines 18-20). Examiner Forman agreed that, based on these citations to Mirzabekov alone, the statement on page 8 of the Office Action that Mirzabekov's disclosure of a Peltier thermostated pin is equivalent to an ink-jet system is incorrect.[1]

In view of the foregoing, it is clear that none of the applied references discloses the use of an ink jet system to form a biochip, as claimed. To date, however, Examiner Forman has not given the "ink jet" feature recited in the pending claims any patentable weight.

Federal Circuit case law and the MPEP clearly state that, when dealing with product-by-process claim limitations, determination of patentability is based on the product itself (see MPEP §2173.05(p) discussing the case law in existence regarding product-by-process claims). These authorities make clear that, if the process by which the product is formed

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[1]See also, Bob Paddock, *Peltier Thermoelectric Coolers*, Circuit Cellar Online (December 1999) <http://www.chipcenter.com/circuitcellar/december99/c129r22.htm> (visited October 14, 2003)(this article provides a detailed discussion of what a Peltier element is and the wide myriad of applications that use Peltier elements).

yields a structurally distinct product, then the product-by-process claim limitation must be given weight in defining patentable subject matter over the prior art product. Based on the results of the quantitative experimentation (i.e., shown in the Table and Graph discussed below), it is undeniable that the claimed ink-jet process provides a structurally distinct biochip product over biochips formed using the pin-head contact devices disclosed in the applied prior art of record (i.e., Audeh, Mirzabekov and Chenchik).

The ink-jet process, as compared to conventional pin-head contact methods, provides a structurally distinct biochip, because of the non-contact nature of the ink-jet process. In accordance with the invention, a first ink-jet sample spot that has a desired spot size (e.g., pending claim 1) and/or a desired capture material concentration (e.g., pending claims 3 and 30) is supplied onto a base plate and allowed to dry. A second ink-jet sample spot, which, for example, can have the same or a different spot size in relation to the first ink-jet sample spot and/or the same or a different capture material concentration, is then supplied on top of the dried first ink-jet sample spot. Due to the non-contact nature of the ink-jet process, the integrity of the dried first ink-jet sample spot is not affected by the delivery of the second ink-jet sample spot. This is not the case with conventional pin-head methods, as discussed below.

Conventional pin-head spotting devices, such as those disclosed in Audeh, Mirzabekov and Chenchik, use pin heads that are brought into contact with the support surface when delivering probe sample solutions onto the support. The pin heads are dipped into sample wells containing the probe sample solution to collect individual probe samples and spot the probe samples onto the substrate by physically tapping the end of each of the pin heads against the upper surface of the substrate. After each probe sample is spotted onto the substrate, each of the pin heads is washed with water and ethanol and air dried before the pin heads are re-inserted into the sample wells to collect another batch of probe sample solution

to be subsequently supplied onto the substrate. After the previously supplied probe sample solution spots have dried, another series of probe sample solution spots are subsequently placed onto the substrate using the washed pin heads in the arraying device. During the application of all subsequent probe sample spots, the pin heads contact the previously applied dried sample solution spots to deposit the subsequently supplied probe sample spots on top of the previously supplied spots.

When the pin head tips contact the dried sample spots, some portion of the spot sticks to the pins, and thus a portion of the previously supplied dried spots is removed during the delivery of every subsequent supplied probe sample spot. As will be shown from the quantitative results of the experimentation discussed below, because the pin heads contact all of the previously supplied probe samples and come into physical contact with the substrate every time a subsequent probe sample spot is deposited in the array, the fine degree of accuracy and precision in spot size formation and capture material concentration per sample spot attributable to the claimed ink-jet process is not possible when the sample spots are pin-spotted onto the support surface.

The Table attached to Mr. Hirota's Declaration shows the results of a direct comparison between the variations of fluorescent signal intensities emitted from ink-jet delivered capture solution spots having target capture material concentrations of "1", "2" or "3", and capture solution spots having the same relative capture material concentrations delivered by a pin-head method. A total of 60 spots were formed on a base plate. Each spot within a first group of 30 spots was formed using the ink-jet method, while each spot in the second group of 30 spots was formed using the pin-head method. After the first drops were allowed to dry, a second sample drop was supplied using the ink-jet method to 20 of the 30 spots in the first group, and a second sample drop was supplied using the pin-head method to

20 of the 30 spots in the second group. After the second drops were allowed to dry, a third sample drop was supplied using the ink-jet method to 10 of the two-drop spots in the first group, and a third drop was supplied using the pin-head method to 10 of the two-drop spots in the second group. The finished test slide, therefore, had two groups of 30 spots, and within each group there were 10 one-drop spots, 10 two-drop spots, and 10 three-drop spots.

A solution including a target material capable of reacting with the corresponding capture materials in the capture solution spots formed on the base plate was then supplied onto each spot. Again, the capture solutions used to form the spots contained relative concentrations of capture materials (i.e., target concentration of capture material 1, 2 or 3) that were adapted to specifically react with the target materials in the target material solution which was, for example, a positive control. The reaction between the capture solution spots and the target material solution caused a fluorescent signal to be emitted from each reacted capture solution spot. The fluorescent signal intensity value from each spot was obtained by subtracting background fluorescence, such as, for example, fluorescence emitted from the base plate itself, from the total fluorescence emanating from the reacted capture solution spots and the base plate. The capture solution fluorescent signal intensities were detected and measured using a conventional scanning apparatus.

The Table attached to Mr. Hirota's Declaration shows that the fluorescent signal intensities emitted from each of the individual spots within each capture spot group of pin-head delivered capture solution spots vary significantly from one another in comparison to the much smaller variation between the signal intensities emitted from the individual spots within each capture spot group of ink-jet supplied capture solution spots. For example, while the standard deviation of signal intensities between ink-jet delivered spots in the relative target concentration capture spot groups 1-3 was 310, 311 and 435, respectively, the standard

deviation of signal intensities between pin-head delivered spots in the same relative target concentration capture spot groups 1-3 was 656, 889 and 979, respectively. The lower standard deviation between the ink-jet delivered capture solution spots, as compared to the higher standard deviation between the pin-head delivered capture solution spots, proves that the claimed ink-jet process consistently delivers capture solution spots having a more precise, desired amount of capture material per sample spot. This is due to the non-contact nature of the ink-jet method.

The relatively higher standard deviation between the pin-head delivered sample spots is due to the disruptive nature of the contact (between the pin and the base plate) that is necessary to perform the pin-head method. These results show that the degree of accuracy and precision in capture material per spot attributable to the claimed ink-jet process is not attainable using prior art pin-head arraying devices, such as those disclosed in Audeh, Mitzabekov and Chenchik.

The comparative table of signals also shows that a significant variation exists between the standard deviation of fluorescent signal intensities emitted from each group of capture solution spots delivered using a pin-head device when compared to the signal intensities of those same groups of capture solution spots supplied onto the base plate via the ink-jet process. For example, while the standard deviation values for the signal intensities between the ink-jet delivered spots in relative target concentration capture spot groups 1 and 2 are practically identical (i.e, the standard deviations are 310 and 311, respectively), a much wider gap exists between the standard deviation values for the signal intensities between the pin-head delivered spots in relative target concentration capture spot groups 1 and 2 (i.e, the standard deviations are 656 and 889, respectively).

The practically identical standard deviation values for the signal intensities emitted from the ink-jet delivered capture solution spots in relative target concentration capture spot groups 1 and 2 is attributable to the non-contact nature of the ink-jet process. That is, the dried first ink-jet sample spot (having a target concentration of 1) is not affected by the delivery of the second ink-jet supplied sample spot (to provide an overall target concentration of 2). The standard deviation values for the signal intensities between the pin-head delivered spots in relative target concentration capture spot groups 1 and 2 varies widely due to the contact nature of the pin-head method. These results show that the more precise, desired amount of capture material per sample spot attributable to the claimed ink-jet process is not attainable using prior art pin-head arraying devices, such as those disclosed in Audeh, Mitzabekov and Chenchik.

The Graph attached to Mr. Hirota's Declaration also provides quantitative proof that the non-contact nature of the claimed ink-jet process makes it possible to reproducibly deliver a more precise, desired amount of capture material per sample spot as compared to prior art pin-contact methods. The graph shows the existence of a linear relationship between the emitted signal intensities (which correspond to the relative target concentrations of each of the sample spots) of each of the ink-jet capture spot groups 1-3. That is, there is a clear linear relationship between the 3 groups. While the signal intensity values for ink-jet capture spot groups 1-3 are tightly packed around their respective average signal intensity values, it is difficult to ascertain whether the emitted signal intensity values for each of the pin-head capture spot groups 1-3 even belong to the same capture spot group. For example, it is clear that the signal intensities for the pin-head capture spot groups 1-3 are widely scattered and there are several instances in which the signal intensity values for one capture spot group overlap with the signal intensity values of another capture spot group. Accordingly, the graph

results provide further proof that the more exact, desired and reproducible amount of capture material per sample spot attributable to the claimed ink-jet process is not attainable using prior art pin-contact arraying devices.

The above experiments quantitatively prove that use of an ink-jet process, as claimed, precisely delivers capture solution spots having a more accurate and reproducible capture material concentration and spot size in comparison to capture solution spots that are supplied onto a base plate using conventional pin-head techniques. Consequently, the results of this experimentation clearly show that the claimed ink-jet process provides a structurally distinct biochip in comparison to a biochip that is fabricated using conventional pin-head methods.

In view of all of the foregoing, reconsideration and withdrawal of the §102(e) rejections over Audeh, Mirzabekov and Chenchik are respectfully requested.

3. Claims 1, 2, 15, 16, 22 and 23 were rejected under §103(a) over Audeh in view of Dean, or Mirzabekov in view of Dean, or Chenchik in view of Dean in paragraphs 15, 17 and 19, respectively, of the Office Action.

The above discussion and quantitative experimental results shown in the attached Table and Graph clearly show that the claimed invention provides a structurally distinct biochip in comparison to the biochips produced using conventional pin-head type arraying devices similar to those disclosed in each of Audeh, Mirzabekov and Chenchik. The PTO's reliance upon the secondary reference Dean for disclosure that a linear relationship exists between spot concentration and spot size does not change the fact that the claimed biochip is patentably distinct over the biochips disclosed in the primary references for the reasons explained above. Consequently, the §103(a) rejections are erroneous and should be withdrawn for this reason alone.

Moreover, there is no disclosure in any of the applied prior art references that would have motivated one skilled in the art to abandon the conventional pin-head contact devices disclosed in Audeh, Mirzabekov and Chenchik in favor of an ink-jet system (as claimed) for any reason, let alone the above-discussed benefits quantitatively proven to be attributable to the ink-jet process as first discovered by Applicants herein.

In view of all of the foregoing, reconsideration and withdrawal of the §103(a) rejections are respectfully requested.

If Examiner Forman believes that contact with Applicants' attorney would be advantageous toward the disposition of this case, she is herein requested to call Applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

Respectfully submitted,

December 18, 2003
Date

Stephen P. Burr
Reg. No. 32,970

SPB:SWC:jms

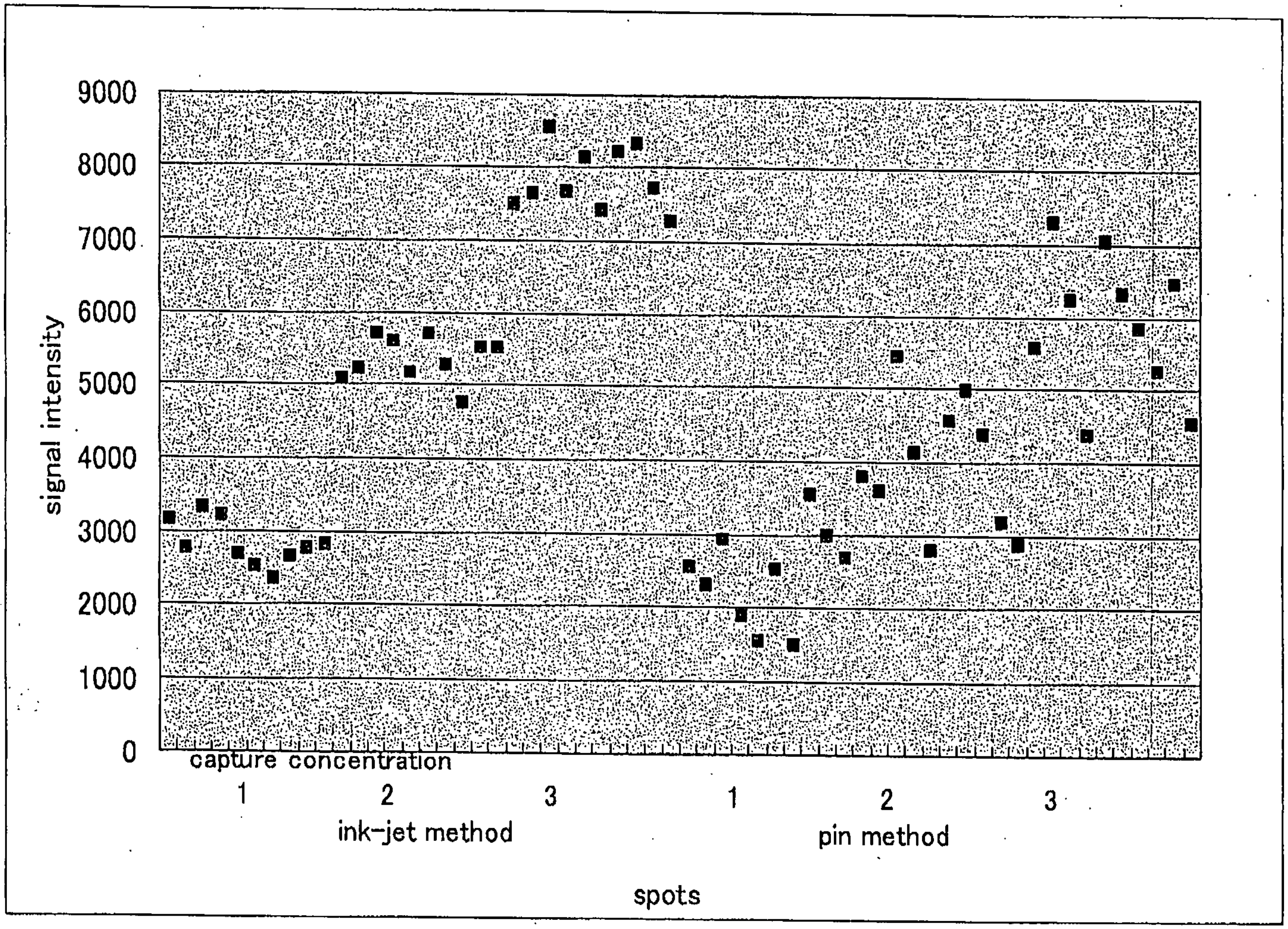
Enclosures: Rule 132 Declaration
Comparative Table of Signals
Comparative Graph of Signal Intensities
Bob Paddock, *Peltier Thermoelectric Coolers*, Circuit Cellar Online (December 1999)

BURR & BROWN
P.O. Box 7068
Syracuse, NY 13261-7068

Customer No.: 025191
Telephone: (315) 233-8300
Facsimile: (315) 233-8320

Comparative table of signals which are obtained ink-jet method and pin method

spotting method	target concentratio of capture	measured value spot	background	signal intensity	average	standard deviation	(%) cofficient of variati
ink-jet method	1	3752	583	3169			
	1	3345	576	2769			
	1	3882	569	3313			
	1	3783	575	3208			
	1	3264	576	2688			
	1	3090	577	2513			
	1	2958	598	2360			
	1	3256	585	2671			
	1	3345	578	2767			
	1	3392	575	2817	2828	310	10.97
	2	5656	573	5083			
	2	5826	580	5246			
	2	6312	582	5730			
	2	6187	576	5611			
	2	5755	574	5181			
	2	6311	581	5730			
	2	5871	570	5301			
	2	5359	585	4774			
	2	6123	574	5549			
	2	6107	571	5536	5374	311	5.79
	3	8084	579	7505			
	3	8222	589	7633			
	3	9142	587	8555			
	3	8246	582	7664			
	3	8720	578	8142			
	3	8030	610	7420			
	3	8805	583	8222			
	3	8928	580	8348			
	3	8310	582	7728			
	3	7847	576	7271	7849	435	5.54
pin method	1	3129	579	2550			
	1	2865	572	2293			
	1	3507	576	2931			
	1	2467	575	1892			
	1	2135	587	1548			
	1	3083	560	2523			
	1	2076	579	1497			
	1	4135	580	3555			
	1	3567	579	2988			
	1	3257	574	2683	2446	656	26.81
	2	4373	574	3799			
	2	4179	568	3611			
	2	6017	564	5453			
	2	4683	566	4117			
	2	3377	580	2797			
	2	5116	551	4565			
	2	5546	562	4984			
	2	4939	567	4372			
	2	3745	568	3177			
	2	3442	560	2882	3976	889	22.36
	3	6153	553	5600			
	3	7856	555	7301			
	3	6819	554	6265			
	3	4921	551	4370			
	3	7598	550	7048			
	3	6889	549	6340			
	3	6414	550	5864			
	3	5797	549	5248			
	3	7040	550	6490			
	3	5102	551	4551	5908	979	16.58



signal intensity
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
capture concentration
1
2
3
ink-jet method
1
2
3
pin method
spots

CIRCUIT CELLAR ONLINE

THE MAGAZINE FOR COMPUTER APPLICATIONS

Circuit Cellar Online offers articles illustrating creative solutions and unique applications through complete projects, practical tutorials, and useful design techniques.

RESOURCE PAGES

RESOURCE LINKS

A Guide to online information about:

Peltier Thermoelectric Coolers

by Bob Paddock

At one time or other most of us have designed a circuit that was not stable during some type of temperature change. So to test it, we get out the Cold Spray and Heat Gun. What we usually end up with is a wet, foggy circuit. What we really need is our own personal environmental chamber, but few of us can afford one. Using Peltier Effect thermoelectric coolers, we can build our own environmental chamber. See *Closed Loop Temperature Regulation Using H-Bridge Motor Controller of a Thermoelectric Cooler.*

First I'll cover the manufacturers of Peltier devices, then I'll cover some of their applications. The applications range from useful OEM products to the truly absurd.

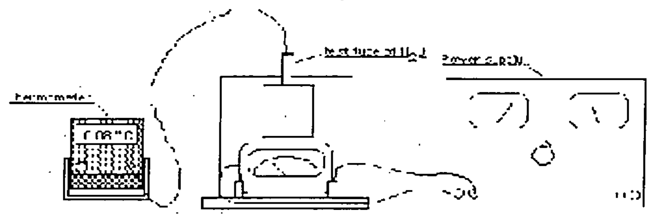
Before we can talk about the Peltier device, a device that gets hot on one side and cold on the other based on the direction of current flow, it would be a good idea to brush up on the fundamentals of temperature and thermodynamics.

About Temperature

The document *About Temperature* was prepared for the middle school math teachers who are taking part in Project Skymath.

This document covers:

- What is temperature?
- The development of thermometers and temperature scales
- Heat and thermodynamics
- The knetic theory
- Thermal radiation
- 3 K - The temperature of the universe



University of Oregon physics demonstration *Thermodynamics: Thermal Properties of Matter Peltier App. -- super cooled water.*

DOE-HDBK-1012/1-92	DOE Fundamentals Handbook, Thermodynamics, Heat Transfer, and Fluid Flow, Volume 1 of 3 (138 pages) PDF (2994 KB)
DOE-HDBK-1012/2-92	DOE Fundamentals Handbook, Thermodynamics, Heat Transfer, and Fluid Flow, Volume 2 of 3 (80 pages) PDF (1193 KB)
DOE-HDBK-1012/3-92	DOE Fundamentals Handbook, Thermodynamics, Heat Transfer, and Fluid Flow, Volume 3 of 3 (82 pages) PDF (1214 KB)

By the year 2000, the culture of the DOE community will be based on standards. Technical standards will formally integrate part of all DOE facility, program, and project activities. The DOE will be recognized as a participant in the use and development of technical standards. The Technical Standards Program will be a benchmark for efficiency, value, and support for the DOE customer.

In support of the Department's Standards Program and in partnership with all stakeholders, the mission is to enhance DOE's transition to a standards-based culture by providing information, co-ordinating activities, and promoting the use of consensus standards, and when needed, the development of DOE technical standards.

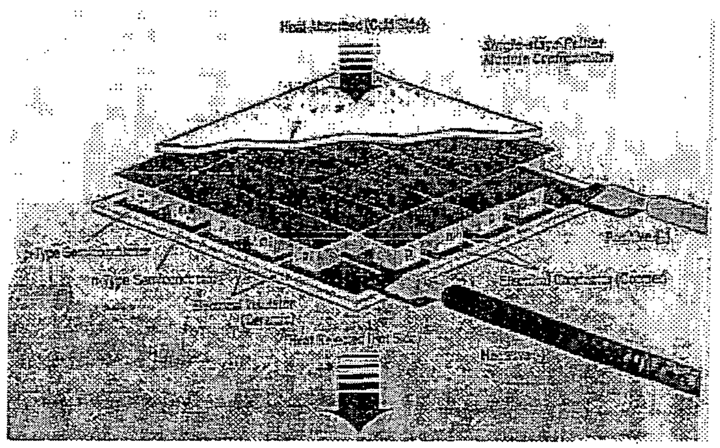
Online Approved DOE Technical Standards

[The few standards that are listed here are the ones relevant to this section, check above link for the complete listing.]

A thermoelectric cooler is a special type of semiconductor that functions as a heat pump. By applying a low-voltage, high-current, DC power source, heat will be moved in the direction of the current (+ to –). The heat is pumped from one side of the module to the other, so that one face will be cold while the opposite face will be heated, and the effect is reversible. This is also known as the Peltier Effect.

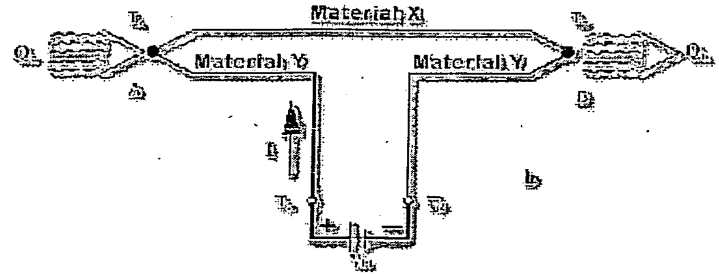
Manufactures of Peltier devices, listed alphabetically:

Alpha & Omega Computer, Inc.
Frequently asked questions about Peltier Effect:

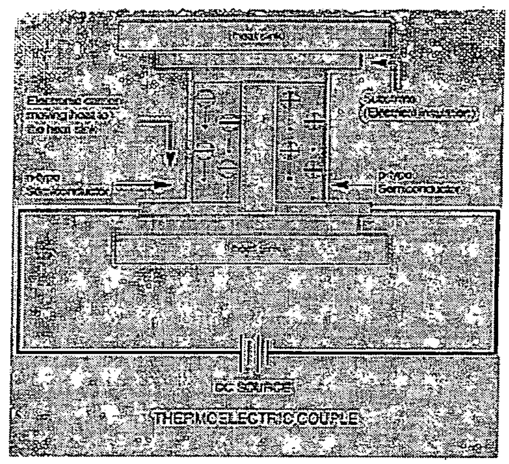


Ferrotec Corporation is a leading manufacturer of small, wafer-like heat pumps called thermoelectric modules and their related assemblies. These products are used to cool or control the temperature in a wide variety of products by utilizing the Peltier Effect.

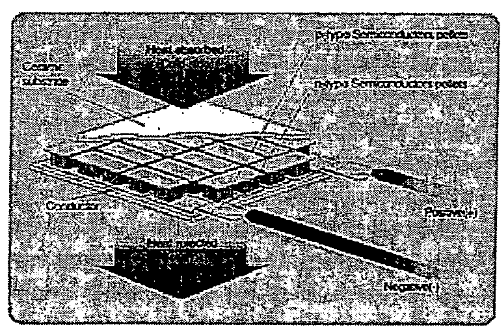
Introduction to Thermoelectric Cooling.



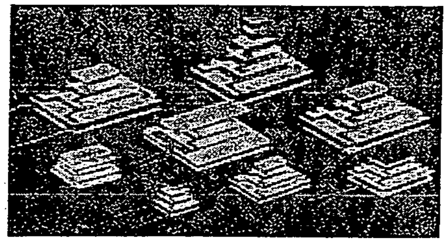
INB Products, Inc. is a worldwide supplier of Thermoelectric modules. Their Peltier products are used in many industries, such as military, commercial, industrial, and consumer.



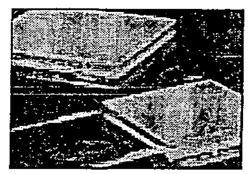
Peltier Effect is the phenomenon used in the thermoelectric refrigeration, with the rate of reversible heat absorption. When current passes through the junction of the two different types of conductors, it results in a temperature change.



Seebeck effect is the phenomenon underlying the conversion of the thermal energy into electrical power. Two dissimilar conductors at different temperatures create a voltage that generates electricity.



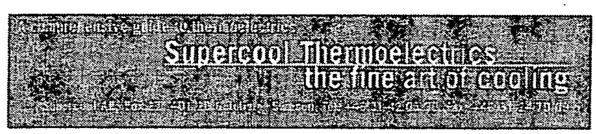
Marlow Industries offers a more detailed FAQ about the Peltier Effect. Marlow Industries, Inc., is the world leader in quality thermoelectric cooling technology.



Melcor Thermal Solutions is one of the main manufacturers of thermoelectric coolers.

Thermoelectric Handbook
Commonly Asked Questions About Thermoelectrics

Thermoelectric Cooler Controller Schematic by Greg Billock and Chuan Xie. This circuit is useful for controlling TECs such as those sold by Melcor.



Supercool Thermoelectrics is a leading OEM supplier of thermoelectric refrigeration equipment. They are certified by the pharmaceutical, laboratory, electronic, marine, refrigeration, and automotive industries.

OEM Applications include:

- AA = Air to air system

- AL = Air to liquid system
- DA = Direct to air system
- DL = Direct to liquid system
- LA = Liquid to air system
- LL = Liquid to liquid system

Thermoelectrics and how it works has some educational graphics that are worth a look.

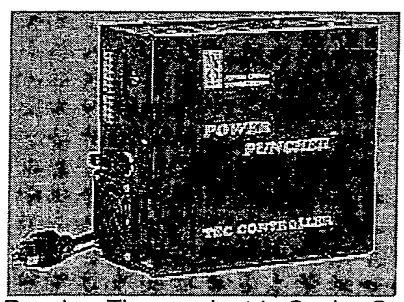
TE Technology designs and manufactures thermoelectric (Peltier) coolers, temperature controllers and test equipment.

Tellurex is the world leader in the manufacture of high-performance thermoelectric (Peltier) modules, used in both cooling and heat/cool applications. A result of years of material research and development, the ZMAX® module—produced exclusively by Tellurex—is recognized throughout the world as the technological benchmark in thermoelectric cooling and heating.

Their 26-page FAQ probably answers any question that you may have.

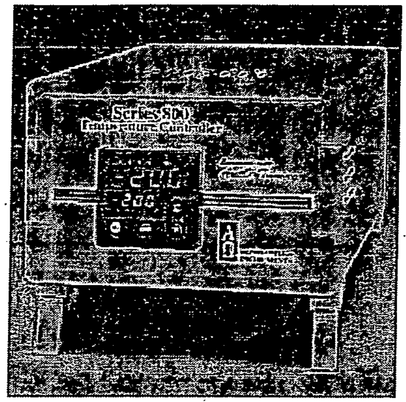
Applications and techniques

Alpha Omega Instruments Corp.

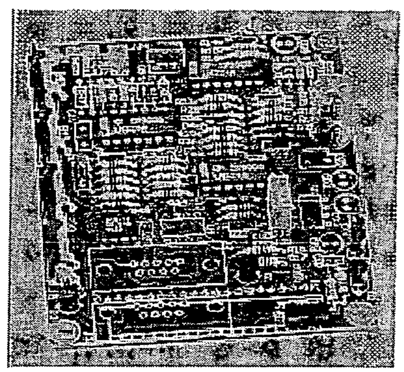


Power Puncher Thermoelectric Cooler Controller

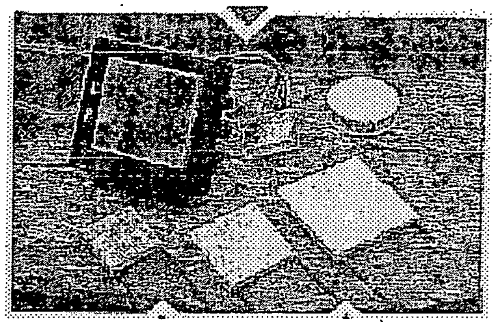
The Power Puncher is a rugged, full-capacity thermoelectric cooler controller that packs a wallop of up to 120 W (15 V @ 8 A). It features a linear, DC current source together with proportional and integral (P/I) temperature control. And, unlike hybrid controller chips that require users to purchase and install heat sinks, printed circuit boards, various electrical components, power supplies, and so on, the Power Puncher is a Plug and Play device.



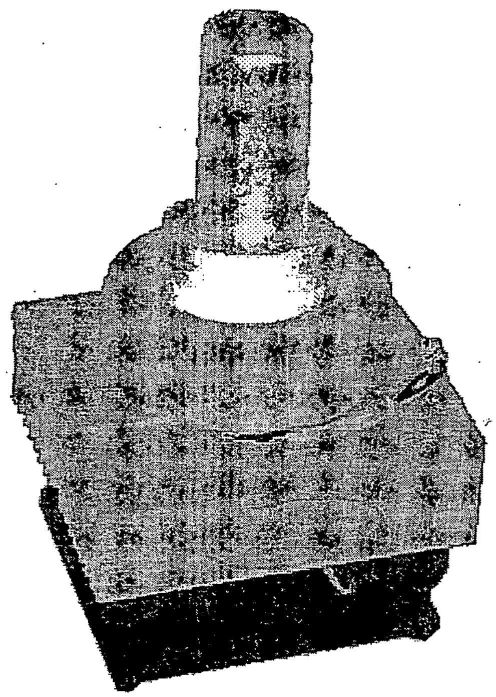
The Series 800 features a user-friendly front control panel. The control panel contains four switches that allow access to the instrument's control settings. In addition, there are two LED digital displays that simultaneously display both actual temperature and set point temperature. The Series 800 thermoelectric cooler controller features proportional, integral, and derivative (PID) control that provides exceptionally tight control over a wide temperature range. The auto-tuning feature helps to ensure maximum performance over a broad spectrum of operating conditions. Auto-tuning sets the critical PID terms to match the conditions of the application and provides fast response while minimizing overshoot and undershoot. From the user's perspective, the need to make frequent manual adjustments has been virtually eliminated.



The Series P-1 Thermoelectric Cooler (TEC) controller board is a high-performance linear analog controller designed to be used with a wide variety of thermoelectric coolers. The controller features an optically coupled MOSFET analog driver together with proportional and integral (P/I) temperature control.



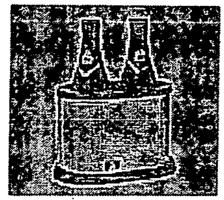
The unique combination of T.E.C. chip, advanced design heat sink, and a quiet, powerful fan acts efficiently to pump the CPU's heat output away from the CPU.



The *Ice Probe*, from Advanced Thermoelectric Products, is a one piece water cooler probe—an easy to install unit that works without compressors, carcinogenic oils, or ozone-depleting gases that may be harmful to the environment. (It is also 90% recyclable.)

Advanced Thermoelectric Products — The Basics

Advanced Thermoelectric Products: Fundamental Thermoelectrics.



Can cooler: This can cooler is provided with a thermoelectric refrigeration module to achieve a small, compact, light and noiseless cooling solution. The thermoelectric module exploits Peltier Effect by doped bismuth telluride, to pump heat.

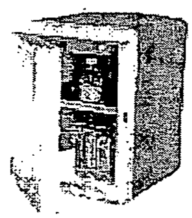
Cascaded Peltier Liquid Cooler
If one Peltier can get things really cold, two should get things colder. Right? Well...
Liquid Cooled CPU Experiments.

Chemical Engineering, Science & Technology Timeline
Compiled by Luis Klemas

CK500 - Peltier Junction Experimenters Kit

This experimenter's kit comes with a 127-element thermo-electric device sandwiched between two large heat sinks. We have also included a PID (proportional integral differential) power control circuit board. From http://electronickits.com/.

Coleman®
Coolers



40Qt. Thermoelectric Cooler 3
Product Number #68-5642-807

- New internal light and auto thermostat control allow quick access to contents and provides a consistent cooler temp.

- LED indicator shows when Auto-thermostatic control is operational
- Door shelf and new internal light
- Can be used horizontally or vertically
- Shelf divider has 3 different positions
- Engineered to open in tight spaces
- Door converts to open left or right

[I've seen smaller versions of this device at local stores, but didn't find any in my web searching.]

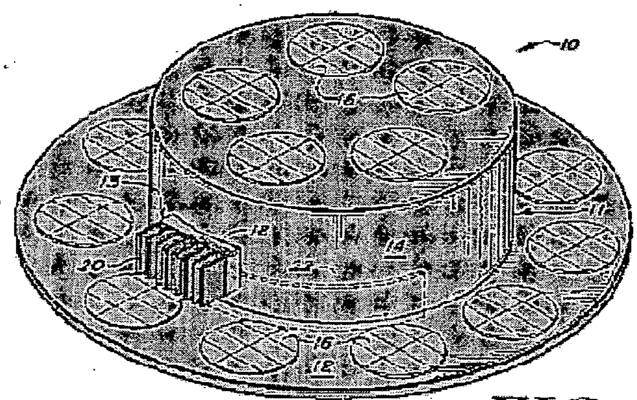


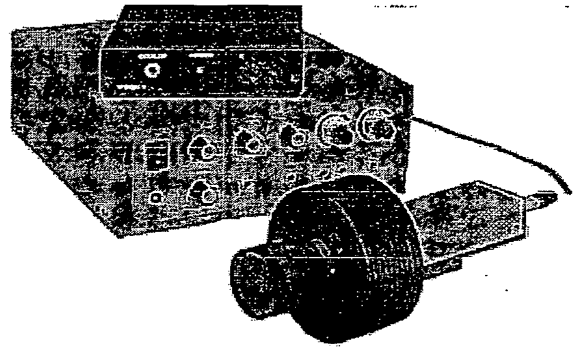
FIG. 1

'Cranium Cooler' US Patent 4,551,857 / Issued 1985
from
http://www.totallyabsurd.com/.

CRC Handbook of Thermoelectrics by Rowe; D.M.

Description:

Thermoelectrics is the science and technology associated with thermoelectric converters, that is, the generation of electrical power by the Seebeck Effect and refrigeration by the Peltier Effect.

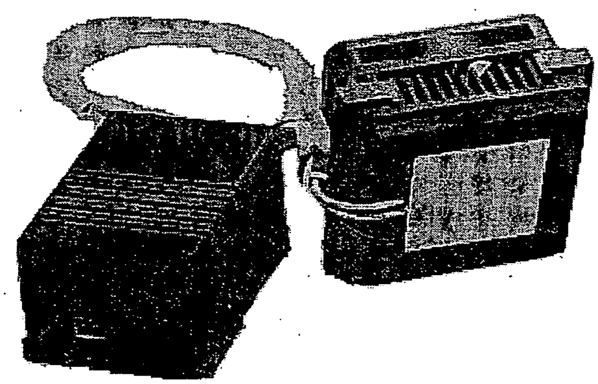


Dage TC-1 Thermoelectric Cooler

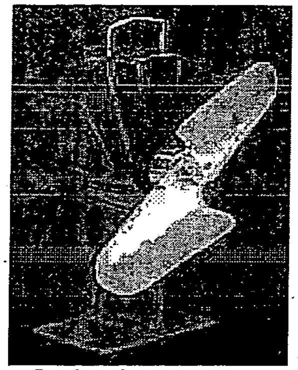
The TC-1 Thermoelectric Cooler is a two-stage Peltier type cooler that lowers the sensor temperature a full 55°C. Eliminating the dark current allows the user to extend integration times and improves both the signal to noise ratio and increases the dynamic range up to 10 bits. The clean, constant power supply optimizes the cooling efficiency without adding more noise to the system. The TC-1 cooling unit is permanently affixed to the CCD camera head. It can be added to some CCD cameras.

Design Ideas: June 8, 1995
Temperature controller drives Peltier cooler
Dr Trevor Preston,
Cambridge, UK

DesTech DESTECH Solutions Inc.
TEL:886-2-28832998 FAX:886-2-28829138



DT-P54A Pentium Peltier Thermoelectric CPU Cooler



Ecofan Stovetop Fan

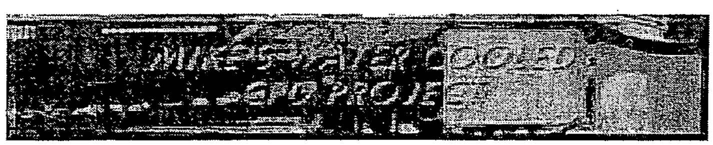
The Caframo Ecofan is a heat-powered fan designed to circulate the warm air created by a wood stove. This fan does not use any batteries or wall cords. The Caframo Ecofan has a thermoelectric module that acts as a small generator to power the fan's motor. When this generator module experiences a heat differential between its top and bottom surfaces, it pumps out electricity. The bottom surface of the module is heated by the base of the fan, while the top of the module is kept cooler by the fan's top cooling fins.

Electronics Cooling

ElectronicsCooling is the premier magazine dedicated to engineers responsible for thermal management in the electronics industry. The magazine's mission is to disseminate practical information that relates to cooling today's electronics.

The Heatsink Guide: Peltier coolers

covers some of the down sides of Peltier Coolers such as the dangers of Peltiers, and how long will they last.

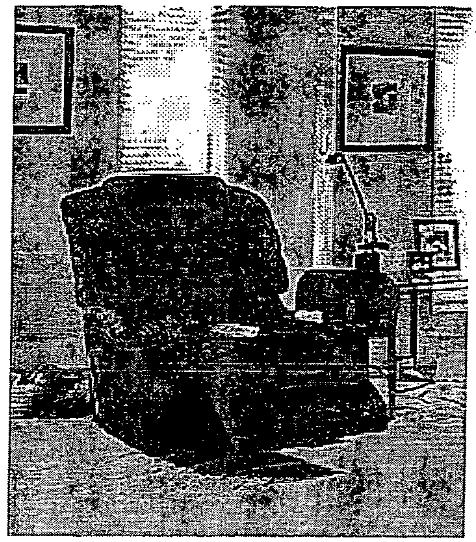


Mike's Water Cooled CPU Project has many useful construction tips involving water jackets and heat exchangers.

Steve J. Noll put together his *Peltier Device (Thermoelectric Heater/Cooler) Info* page. I wish I had found it earlier in my search of Peltier info, he had all the hard work done for me.

Over clocking to Extreme! The Water-Cool News.

Only for all of you radical overclockers.



The days of having to leave the comfort of your recliner to go to the kitchen are over. Oasis is the first ever recliner to feature a beverage cooler built right into the arm of the chair. The thermoelectric refrigeration unit holds up to six 12-ounce cans.

Unitrode Corporation has several unique application notes dealing with H-Bridges.

TI has announced plans to acquire Unitrode Corporation.

Closed Loop Temperature Regulation
Using the UC3638 H-Bridge Motor Controller and
Thermoelectric Cooler

Class-D Amplifier for Thermoelectric Devices DN-76

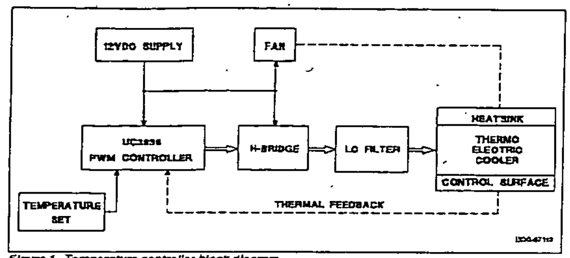
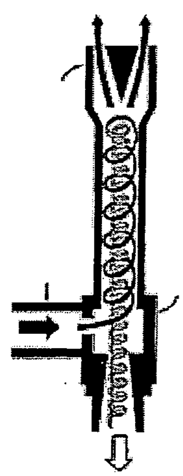


Figure 1. Temperature controller block diagram.
02/99

Have you ever wanted to test an IC over temperature, but couldn't put the entire application circuit in the oven? Maybe you needed to access critical circuit nodes for troubleshooting, or observe the effects of temperature on only one component. Freeze sprays and hair dryers may be good for benchtop troubleshooting, but the temperature (and temperature slew rate) is highly uncontrolled and may actually damage the part. Forced-air systems that direct temperature controlled air to a specific area are available, but they are large, cumbersome, and expensive. What is needed is a portable, low-cost, temperature forcing system.

One solution is to use a thermoelectric cooler. Thermoelectric coolers employ the Peltier Effect, acting as small, solid state heat pumps when a DC current is passed through them. They are relatively small, flat devices which transfer heat from one side to the other. The direction of heat transfer can be reversed, for heating or cooling, by simply reversing the direction of the current. The amount of heat transfer is controlled by the magnitude of the current. A temperature difference achieved using a single element, if proper heat sinking is provided on one side of the device. Larger temperature gradients can be produced by stacking multiple elements. They can be used effectively as part of a closed loop temperature regulation system.



Vortex Tube Phenomenon

While the Vortex Tube has nothing at all to do with the Peltier Effect, I thought it was a interesting method of cooling. A real-world implementation of Maxwell's Demon, where ambient temperature goes in the middle of the Vortex Tube, and hot air comes out one end, while cold air comes out the other.

The vortex tube was discovered in 1930 by French physicist Georges Ranque. Vortec was the first company to develop this phenomenon into practical, effective cooling solutions for industrial applications.

If you would like to add any information on this topic or request a specific topic to be covered, contact Bob Paddock.
